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(54) **Foaming agents for cement**

(57) Foaming agent for preparing foamed cement insulating panels comprises alkali metal monoalkylolamido sulphosuccinate and alkyl or alkyl ether sulphate. The composition may be used to form a prefoam for admixture with cement, especially cements of low or zero sand content, and provides a foamed cement of improved foam stability.

The sulphosuccinate is an alkali metal salt of a sulphosuccinate half ester of an alkylolamide or alkylolamide ether of the formula $RCONH(R'O)_nH$ where R is a straight or branched chain saturated or unsaturated hydrocarbon group of 6 to 22 carbon atoms, R' is an alkylene group of 2 to 3 carbon atoms and n is 1 to 20. The sulphate has a branched or straight chain alkyl group having from 6 to 22 carbon atoms and from 0 to 20 alkyleneoxy groups.

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SPECIFICATION

Foaming agents for cement

The invention relates to the use of certain surfactant blends as foaming agents for cement and sand/cement slurries. Such slurries are used to produce lightweight "foamed concrete" which is used as an insulation medium in buildings. Foamed concrete is typically produced by adding a "prefoam" of surfactant and water to the cement-containing slurry, mixing the compounds and pumping the mixture to a mould where it is allowed to set. Current foaming agents are not fully satisfactory, particularly when high cement content mixes are used, as the foam in the final mixture is not stable. We have found that certain surfactant blends, including some previously proposed for use as carpet shampoos (see for example U.S.P. 3862823) are very effective foaming agents for cement and cement/sand slurries and give foams which are more stable on standing than those prepared hitherto. The improvement is particularly marked in mixes of high cement content.

Our invention according to a first aspect provides a composition for use as a cement foaming agent comprising (A) at least 20% by weight of the total surface active ingredient of an alkali metal monoalkylolamido sulphosuccinate as defined herein and (B) at least 5% by weight of the total surface active ingredient of an alkali metal alkyl sulphate or alkali metal alkyl ether sulphate.

The term "alkali metal monoalkylolamido sulphosuccinate" as used herein means an alkali metal salt of a sulphosuccinate half ester of an alkylolamide or alkylolamide ether of the formula $RCONH(R'O)_nH$ wherein R is a straight or branched chain saturated or unsaturated hydrocarbon group of 6 to 22 carbon atoms, preferably 8 to 20 carbon atoms, e.g. 10 to 14 carbon atoms and R' is an alkylene group of 2 to 3 carbon atoms and n is from 1 to 20, e.g. 1 to 5.

Typical examples of suitable alkylolamides of alkylolamide ethers include coconut mono (hydroxyethyl bisoxyethyl) amide, coconut monoethanolamide, oleic monoisopropanolamide, lauric mono (hydroxyethyl bisoxyethyl) amide and lauric monoethanolamide.

Preferably the proportion of sulphosuccinate is from 30 to 85% by weight more preferably 40 to 75% most preferably 50 to 70% e.g. 60 to 68% of the weight of surface active material.

The alkyl sulphate or alkyl ether sulphate has a branched or straight chain alkyl group having from 6 to 22 preferably 8 to 20, e.g. 10 to 18 carbon atoms and from 0 to 20, e.g. 0 to 4 alkyleneoxy groups, preferably ethyleneoxy groups. Typical examples include lauryl sulphate and lauryl alcohol three mole ethoxylate sulphate. The alkyl sulphate or alkyl ether sulphate is preferably present in a proportion of 15 to 70% more preferably 25 to 60%, most preferably 30 to 50%, e.g. 32 to 40% of the weight of surface active material.

It is preferred that the total surface active component of our novel composition consists essentially of the ingredients (A) and (B) as hereinbefore specified. The composition may additionally contain water in an amount sufficient to maintain fluidity. The amount of water is not critical and will typically be from zero to about 75% of the total weight of the mixture at the point of manufacture, e.g. 40 to 70%. In use the mixture may be diluted to a working concentration which is usually between 0.1% and 4%, preferably 0.2% to 2%, e.g. 0.9% to 1.8% by weight of solids.

Apart from the surface active material specified above and water our composition may optionally contain minor proportions, e.g. 0.1% to 4%, based on the weight of solids, of free fatty acid monoethanolamide, usually introduced with the sulphosuccinate as unreacted starting material. The free amide can sometimes contribute to the performance of the composition, so that although the normal impurity level is typically between 0.25 and 2% by weight of the solids, higher levels, e.g. between 2 and 5% or even higher, e.g. up to 10% or even 20% may sometimes be produced by deliberate additions.

Similarly the composition may contain unsulphated fatty alcohols or ethoxylated alcohols such as those used to prepare the sulphate component of our mixture. They may be present in substantially the same proportions and preferred proportions as those described hereinbefore in relation to the free amide.

The product may contain traces of inorganic material such as alkali metal sulphate formed as an impurity during the preparation of the sulphate surfactant.

The alkali metal cations in our composition are preferably sodium but may alternatively be potassium or lithium or mixtures.

Our invention according to a second aspect provides a method of manufacturing foamed concrete by preparing an aqueous slurry of cement and optionally sand and mixing with it a prefoam comprising water, a foam stabilising amount of a composition according to the first aspect of our invention and air. Preferably the composition of our invention is diluted to the working concentration and stirred vigorously to generate the prefoam.

According to a third aspect our invention provides foamed concrete prepared by the aforesaid method, and foamed concrete containing an effective amount of a composition according to the first aspect of our invention.

The weight of sand used may typically be from zero up to four times the weight of cement, or even higher. Water is added to give a workable slurry and the quantity required depends on the proportion of sand in the mixture. Typical volumes are 300 to 500 ml e.g. 400 ml water per kg cement for a cement

only mix, 400 to 600 ml, e.g. 500 ml water per kg cement for a 1/1 sand/cement mix, and 600 to 1,800 ml, e.g. 1,200 ml water per kg cement for a 4/1 sand/cement mix.

The invention is illustrated by the following examples, of which Examples (i) to (xii) are comparative and Examples 1 to 24 use compositions of the invention.

EXAMPLE (i)

Cement (1 kg) and water (400 ml) were mixed in a Hobart mixer, speed 1.

25 ml of a 4% solution of disodium cocosulphosuccinate (40% solids) a typical commercial foaming agent, was then foamed in a container using a simple paddle stirrer to a volume of approximately 350 ml. This foam was then added to the stirred cement/water mix. A further 3 portions of foam (100 ml aqueous surfactant solution in all) were then added. The mix was then stirred for approximately 5 minutes when the foam density was at a stabilised level.

The foam produced was then assessed by measurement of:—

a) density;

b) stability, a palette knife was drawn through the foam and the bubbles exposed should not break.

The density was 0.62 which is acceptable but the stability was totally unsatisfactory; the bubbles broke readily.

EXAMPLES (ii) to (vii)

The procedure of Example (i) was repeated using each of the following commercial surfactant compositions in turn as the foaming agent:

(A1) Disodium cocomonoethanolamide sulphosuccinate (35% solids);
(A2) Disodium cocomonoethanolamidediethoxylate sulphosuccinate (50% solids):
(A3) Disodium oleicisopropanolamide sulphosuccinate (35% solids);
(B1) Sodium lauryl sulphate (28% active);
(B2) Sodium lauryl alcohol three mole ethoxylate sulphate (27% active);

The concentration by weight of each surfactant composition used, the volume of water mixed with each kg cement, and the density and stability of the resulting foamed concrete are summarised in Table 1. The term "wet" used in Table 1 indicates that the foam was completely unstable as water separated out from it.

TABLE 1

Example	Surfactant and concentration		ml water per kg cement	Density	Stability
(ii)	A1	4.0%	380	0.46	wet
(iii)	A2	1.0%	350	wet	good
(iv)	A3	3.4%	380	0.54	poor
(v)	A3	4.57%	380	0.55	poor
(vi)	B1	5.71%	380	0.59	poor
(vii)	B2	5.93%	380	0.23	moderate

EXAMPLES 7 to 9

Compositions according to the invention were produced by mixing compositions A1 and B1, A2 and B1, A3 and B1 in various proportions. The mixtures were diluted to working concentration and the procedure of Example (ii) was repeated using each diluted mixture in turn as the foaming agent. The results are summarised in Table 2.

TABLE 2

Example	Surfactants and concentrations	ml water per kg cement	Density	Stability
1	A1 3.2% B1 0.8%	380	0.38	good
2	A1 2.4% B1 1.6%	380	0.33	good
3	A1 1.4% B1 1.6%	380	0.34	good
4	A2 0.5% B1 0.5%	350	0.54	good
5	A2 0.3% B1 0.7%	350	0.47	good
6	A3 2.7% B1 0.8%	380	0.42	good
7	A3 2.0% B1 1.6%	380	0.40	good
8	A3 1.4% B1 2.4%	380	0.49	quite good
9	A3 2.97% B1 2.00%	400	0.38	good

EXAMPLES 10 to 13

A composition according to the invention was produced by mixing B1 with a commercial surfactant solution (A4) Disodium lauricmonoethanolamide sulphosuccinate (40% solids) having a free lauric monoethanolamide content of 1.2%.

Further compositions according to the invention were produced by adding to the above composition various proportions of lauric monoethanolamide (LME). The procedure of Example (ii) was repeated using each composition in turn, diluted to working concentration, as the foaming agent. The results are summarised in Table 3.

TABLE 3

Example	Concentration based on total composition A4	B1	LME	Concentration of LME based on solids	ml water per kg cement	Density	Stability
10	2.6%	2.0%	–	1.8%	400	0.37	good
11	2.6%	2.0%	0.05%	4.8%	400	0.37	good
12	2.6%	2.0%	0.15%	10.7%	400	0.37	good
13	2.6%	2.0%	0.30%	17.2%	400	0.34	good

EXAMPLES 14 to 16

Compositions according to the invention were produced by mixing compositions A3 and B2 in the two different proportions and compositions A4 and B2. The procedure of Examples (ii) was repeated using each of the three solutions in turn, diluted to working concentration, as the foaming agent. The results are summarised in Table 4.

TABLE 4

Example	Surfactants and concentrations	ml water per kg cement	Density	Stability
14	A3 2.97% B2 2.00%	380	0.46	good
15	A3 2.29% B2 2.86%	380	0.54	good
16	A4 2.6% B2 2.0%	300	0.40	good

EXAMPLE (viii)

Cement (1 kg), sand (1 kg) and water (450 ml) were mixed in a Hobart mixer, speed 1.

25 ml of a 4% solution of disodium cocosulphosuccinate (40% solids) was then foamed in a container using a simple paddle stirrer to a volume of approximately 350 ml. This foam was then added

to the stirred cement/sand/water mix. A further three portions of foam (100 ml aqueous surfactant solution in all) were then added. The mix was then stirred for approximately 4 minutes when the foam density was at a stabilised level.

The foam produced was then assessed by measurement of:—

a) density;

b) stability, a palette knife was drawn through the foam and the bubbles exposed should not break.

The foam produced had a density of 0.70 but the stability was poor.

EXAMPLES (ix) to (xi) and 17 to 22

The procedure of example (viii) was repeated using as foaming agent each in turn of the compositions of Examples (v), (vi), (vii), 9, 14, 15, 10, 13, and 16 diluted to the same working concentration as in those examples. The results are summarised in Table 5.

TABLE 5

Example	Component(s) and Concentration(s)	ml water per kg cement	Density	Stability
(ix)	A3 4.57% – –	500	1.05	poor
(x)	B1 5.71% – –	500	0.82	poor
(xi)	B2 5.93% – –	450	0.95	moderate
17	A3 2.97% B1 2.00% –	500	0.70	good
18	A3 2.97% B2 2.00% –	450	0.75	good
19	A3 2.29% B2 2.86% –	450	0.73	good
20	A4 2.6% B1 2.0% –	500	0.83	good
21	A4 2.6% B1 2.0% LME 0.30%	500	0.84	good
22	A4 2.6% B2 2.0% –	450	0.68	good

EXAMPLE (xii)

Cement (1 kg), sand (4 kg) and water (750 ml) were mixed in a Hobart mixer, speed 1.

25 ml of a 4% solution of disodium cocosulphosuccinate (40% solids) was then foamed in a container using a simple paddle stirrer to a volume of approximately 350 ml. This foam was then added to the stirred cement/sand/water mix. A further three portions of foam (100 ml aqueous surfactant solution in all) were then added. The mix was then stirred for approximately 5 minutes when the foam density was at a stabilised level.

The foam produced was then assessed by measurement of:—

a. density

b. stability, a palette knife was drawn through the foam and the bubbles exposed should not break

The foam produced had a density of 1.08 and was fairly stable.

EXAMPLES 23 and 24

The procedure of Example (xii) was repeated using as foaming agent the composition of Example 9 at the same working concentration as it was used in that example. It was repeated again using the composition of Example 13 at the same working concentration as in Example 13. The results are summarised in Table 6.

TABLE 6

Example	Components and concentrations	ml water per kg cement	Density	Stability
23	A3 2.97% B1 2.00% –	1200	1.07	moderate
24	A4 2.6% B1 2.00% LME 0.30%	1200	1.07	good

Each surfactant concentration given in the foregoing Tables is the percentage by weight of that commercial surfactant composition which is present in the composition at the working concentration.

CLAIMS

1. A composition for use as a cement foaming agent which composition comprises:—

(a) at least 20% by weight of the total surface active ingredient of an alkali metal monoalkylolamido sulphosuccinate, which sulphosuccinate is an alkali metal salt of a sulphosuccinate half ester of an alkylolamide or alkylolamide ether of the formula $RCONH\ (R'O)_n\ H$ wherein R is a straight or branched chain saturated or unsaturated hydrocarbon group of 6 to 22 carbon atoms, R' is an alkylene group of 2 to 3 carbon atoms and n is from 1 to 20 and

(b) at least 5% by weight of the total surface active ingredient of an alkali metal alkyl sulphate or alkali metal alkyl ether sulphate which has a branched or straight chain alkyl group having from 6 to 22 carbon atoms and from 0 to 20 alkyleneoxy groups.

2. A composition according to claim 1 for use as a cement foaming agent which composition comprises free fatty acid monoethanolamide.

3. A composition according to claim 2 for use as a cement foaming agent wherein the proportion of free fatty acid monoethanolamide is 2 to 20% by weight of the solids.

4. A composition according to any preceding claim for use as a cement foaming agent wherein R is a straight or branched chain saturated or unsaturated hydrocarbon group of 10 to 14 carbon atoms.

5. A composition according to any preceding claim for use as a cement foaming agent wherein n is from 1 to 5.

6. A composition according to any preceding claim for use as a cement foaming agent wherein the alkali metal alkyl sulphate or alkali metal alkyl ether sulphate has a branched or straight chain alkyl group having from 10 to 18 carbon atoms.

7. A composition according to any preceding claim for use as a cement foaming agent wherein the alkali metal alkyl sulphate or alkali metal alkyl ether sulphate has from 0 to 4 alkyleneoxy groups.

8. A composition according to any preceding claim for use as a cement foaming agent wherein (A) comprises 30 to 85% of the total surface active ingredient.

9. A composition according to any preceding claim for use as a cement foaming agent wherein (B) comprises 15 to 70% of the total surface active ingredient.

10. A composition according to any preceding claim for use as a cement foaming agent wherein (A) and (B) together with any free fatty acid alkylolamide comprise substantially all of the surface active ingredient.

11. A composition according to any preceding claim substantially as described herein with reference to any of examples 1 to 24 for use as a cement foaming agent.

12. A method of manufacturing foamed concrete which comprises preparing an aqueous slurry of cement and mixing it with a prefoam comprising water, a foam stabilising amount of composition as specified in any preceding claim and air.

13. A method according to claim 12 wherein the aqueous slurry comprises sand.

14. A method according to claim 13 wherein the weight ratio of sand to cement is from 1:1 to 4:1.

15. Foamed concrete containing an effective amount of a composition according to any of claims 1 to 11.

16. Foamed concrete prepared by the method of any of claims 12 to 14.

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